

## ***Interactive comment on “Black Carbon physical and optical properties across northern India during pre-monsoon and monsoon seasons” by James Brooks et al.***

### **Anonymous Referee #1**

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The submitted manuscript presents detailed airborne in situ measurements of Black Carbon (BC) aerosols taken during different flights over northern India (Indo-Gangetic Plain or IGP) covering pre-monsoon and monsoon seasons. The characteristics of aerosols over the region are presented regarding high-quality vertical and spatial measurements of optical and microphysical properties of BC. The measurement dataset reveals higher concentration of BC over central IGP than that over northwest and northeast region during pre-monsoon season. Also, the BC particles over IGP and northeast regions are found to be moderately coated with enhanced core size and increased strength in mass absorption and scattering. Notably, these effects are seen pronounced at higher altitudes than in boundary layer. With the arrival of monsoon,

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the concentration of BC particles reduced considerably over IGP and northeast, but remained relatively consistent in northwest. Larger coating thickness, core size of BC, and enhanced absorption and scattering strengths across Indo-Gangetic Plain and north-east India during the pre-monsoon and monsoon are indicative of solid fuel burning that forms the greatest proportion of BC over the study region.

The airborne measurements presented in the paper bring new detailed information about spatial and vertical distribution of BC aerosols over northern India that can help improve our understanding of role of BC in radiative forcing and constraint aerosol representation in the chemistry-climate models. It is practically hard to verify each and every observation reported in this paper. However, the findings are generally consistent with those reported in earlier studies and follow a general understanding of aerosol variability and meteorology in the region.

During the review, I came across two major points that author should consider while revising the paper. First, the authors present and discuss the coating of BC particles and associated optical and microphysical properties, but do not mention about the possible coating of BC on coarse mode dust particles. The latter situation is as important as the former one since it poses a great potential of changing the particles' radiative properties, thereby radiative forcing. Second, the paper doesn't discuss, at least briefly, the similarities and/or discrepancies between the measured BC properties and those assumed in the climate-chemistry models for the study region. A general discussion highlighting the importance of new measurements given the current understanding of BC aerosols would greatly enhance the scientific value of the paper.

The article is generally well-written, however, needs some attention to improve the presentation, e.g., long sentences, punctuations, and ambiguities. The content presented in the paper certainly fits into the scope of the ACP journal and can be published given above two major points are addressed. I am listing below some specific suggestions on the paper with this report. – Page 2, Abstract, line 17: “..compared to that in the boundary layer” Page 2, Abstract: Define Indo-Gangetic Plain as IGP first in the

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abstract and use IGP for rest of the abstract to reduce the word count. Follow same terminology in Introduction and onwards. Page 2, Abstract, line 29-31: The findings will also help constraint the regional aerosol models for a variety of applications such as space-based remote sensing, chemistry transport model, and air quality. Page 3, Introduction, line 5-7: IGP serves as a unique natural aerosol laboratory influenced by seasonal sources of aerosols. Authors may cite specific studies/papers out there that highlight seasonal loadings of dust and anthropogenic aerosols. Page 3, Introduction, line 8-9: This is now a general understanding supported by numerous studies. Citing here the IPCC report or some high-impact factor on this subject would be more appropriate. Page 3, Introduction, line 10: How about citing some benchmark papers of Tami Bond, who has done fundamental research on BC and its role in radiative heating. Page 3, Introduction, line 13: I assume here that the central/southern Africa is the largest source of BC, and it is worth to mention it here with a corresponding citation. Page 3, Introduction, line 16-17: What is the contribution of agricultural biomass burning in BC loadings over IGP? The region undergoes intensive crop residue burning in post-monsoon (paddy burning) and pre-monsoon (wheat burning) emitting substantial amounts of carbonaceous aerosols into the atmosphere. Page 4, line 6: Define S2P here and then use abbreviation for the rest of the paper. Page 8, line 24: Some inconsistencies here. Please rewrite the sentence. Page 8, about coating thickness: Can the measurements and analysis shown here infer the properties of BC coating material? Mineral dust? Sulfate, Nitrate? Or humidification? Also, pre-monsoon period is also characterized with transported dust particles in the region. How about coating of dust with BC? Did the measurements/analysis show BC coating coarse mode particles? This is important because studies have shown that the absorption properties of BC coating over dust are significantly different (more absorbing, lower SSA) than pure mineral dust (less absorbing, higher SSA). Page 8, line 29: I wouldn't locate Bhubaneswar in NE; it is actually towards South-East of Indian subcontinent. Page 8, line 30: Shouldn't it be Figure 4 and Figure 5? Page 9, line 8-10: Confusing. Please consider restricting the sentences. Page 9: What is EAL? It isn't defined anywhere in

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the manuscript. Page 11, Mass Absorption Coefficient, 1st paragraph: The possible reason for lower MAC over IGP and relative higher MAC in NW and NE isn't understood. Page 11, line 28-29: is it because of possibilities of elevated fine dust particles coated with BC?

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